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Revised Appeal Brief

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS AND INTERFERENCES

In re application of Craig S. Calvert	§ § §	Confirmation No.: 7470
Serial No. 09/934,320	§ §	Examiner: Everett Williams
Filed: August 21, 2001	§ §	Art Unit: 2128
Title: "Method for Constructing 3-D Geologic Models by Combining Multiple Frequency Passbands"	§ § §	

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SUPPLEMENTAL APPEAL BRIEF

- Proposed Draft - Do Not Enter -

Sir:

APPEAL BRIEF PURSUANT TO 37 C.F.R. §§ 41.37

This Supplemental Appeal Brief is being filed in response to the Notice of Non-Compliant Appeal Brief mailed on October 16, 2006 and in furtherance to the Appeal Brief submitted on June 27, 2006. The Examiner is hereby authorized to charge the assignee's Deposit Account No. 05-1328 for any necessary fees.

1. **REAL PARTY IN INTEREST**

The real party in interest is ExxonMobil Upstream Research Company, the Assignee of the above-referenced application by virtue of the Assignment recorded at reel 012109, frame 0353, and recorded on August 21, 2001. ExxonMobil Upstream Research Company, the Assignee of the above-referenced application, as evidenced by the documents mentioned above, will be directly affected by the Board's decision in the pending appeal.

2. **RELATED APPEALS AND INTERFERENCES**

Appellants are unaware of any other appeals or interferences related to this Appeal.

3. **STATUS OF CLAIMS**

Claims 1-29 are currently under final rejection and, thus, are the subject of this appeal.

4. **STATUS OF AMENDMENTS**

Appellants have not submitted any amendments to the claims subsequent to the Final Office Action mailed on November 28, 2005. However, Appellants have submitted an affidavit under Rule 1.132 subsequent to the Final Office Action, which was entered by the Examiner.

5. **SUMMARY OF THE CLAIMED SUBJECT MATTER**

The present invention relates generally to the field of geologic modeling. Geologic modeling involves a process that assigns values of the rock-properties of interest to all blocks within a geologic model, which is a process known to practitioners of geologic modeling. *See* Application, page 2, para. 0003. Because spectral frequency is a representation of scale in the space domain, it is useful to consider the frequency content of the input data when building the geologic model. *See id.* at page 3, para. 0005. For instance, short-range or fine-scale variability in the reservoir corresponds to high-frequency heterogeneity, whereas long-range or coarse-scale variability corresponds to low-frequency heterogeneity. *See id.* Accordingly, a defined frequency band representing a specific spatial scale can be filtered from this composite spectrum in the frequency domain. *See id.* at page 3, para. 0006.

Disadvantageously, known prior art geologic modeling technologies do not properly account for different spatial scales of multiple diverse data types. *See id.* at page 7, para. 0016. In particular, most prior art geologic-modeling technologies fail to recognize that different data types used in constructing the model contain information at different scales and frequency content. *See id.* at page 7, para. 0017. This deficiency is particularly true when integrating seismic information into the geologic model. *See id.* Seismic-amplitude data does not contain significant low-frequency information. *See id.* As a consequence of omitting this information, seismic data does not directly measure absolute rock property values nor generally measure slowly varying trends in these properties, e.g., as a result of burial compaction. *See id.* Similarly, seismic-amplitude data does not contain significant high-frequency information. *See id.* at page 8, para. 0018. As a consequence of omitting this information, seismic data measures properties over volumes of the subsurface which are much coarser than that measured by well data. *See id.* While some geologic-modeling technologies attempt to account for the different spatial scales of multiple diverse data types by constructing the model in the space domain or in the frequency domain, deficiencies in these methods include an inability to identify spatial components that have physical interpretations, a difficulty in controlling model perturbations, and, most notably, an assumption that the individual spatial components are independent sources of information. *See id.* at page 8, para. 0019.

However, one embodiment of the present techniques is recited in claim 1. Specifically, claim 1 recites:

> A method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria, comprising the steps of:
> (a) generating an initial frequency-passband model of the subsurface earth volume for at least one frequency passband;
> (b) assigning values for at least one rock property in each initial frequency-passband model;
> (c) combining the initial frequency-passband models to form an initial complete three-dimensional geologic model of the subsurface earth volume; and
> (d) optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria.

These recitations relate to one embodiment of a method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria. The method includes generating an initial frequency-passband model of the subsurface earth volume for at least one frequency passband and assigning values for at least one rock property in each initial frequency-passband model. *See id.* at Figs. 2, 3 and 5A; page 8, para. 0021 to page 9, para. 0024; page 11, para. 0027 to page 12, para. 0028; page 15, para. 0037 to page 16, para. 0039. Then, the initial frequency-passband models are combined to form an initial complete three-dimensional geologic model of the subsurface earth volume; and the initial complete three-dimensional geologic model is optimized by perturbing the rock property values in at least one of the models according to specified geological criteria. *See id.* at Figs. 4, 5A-5B; page 12, para. 0029 to page 14, para. 0034; page 16, para. 0040 to page 23, para. 0056.

Another embodiment of the present techniques is recited in claim 18. Specifically, claim 18 recites:

> A method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria, comprising the steps of:
> (a) specifying an initial geologic architecture to define the limits of the model, the regions within the model, and stratigraphic correlations within the model;
> (b) creating a three-dimensional array of contiguous model blocks to represent all portions of the subsurface earth volume to be included within the model;
> (c) assigning initial rock-property values to all model blocks in at least one initial frequency-passband model;
> (d) combining the initial frequency-passband models to form an initial complete three-dimensional geologic model of said subsurface earth volume;
> (e) specifying training criteria for the initial complete geologic model;
> (f) calculating statistics that describe the characteristics of the assigned rock-property values in the complete geologic model;
> (g) calculating the initial objective function;
> (h) perturbing the rock-property values in the complete geologic model so that the rock-property values more closely correspond to the training criteria;
> (i) calculating the objective function for the new tentative model;
> (j) retaining the perturbed rock-property values and the new tentative objective function if the objective function is reduced;
> (k) repeating steps (h) through (j) until the objective function is reduced to a specified limit; and
> (l) outputting the final complete geologic model to file.

These recitations describe a method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria. In this method, an initial geologic architecture is specified to define the limits of the model, the regions within the model, and stratigraphic correlations within the model. *See id.* at Figs. 3 and 5A; page 11, para. 0027; page 15, para. 0037 to page 16, para. 0039. Then, a three-dimensional array of contiguous model blocks is created to represent all portions of the subsurface earth volume to be included within the model and initial rock-property values are assigned to all model blocks in at least one initial frequency-passband model. *See id.* at Fig. 3; page 11, para. 0027 to page 12, para. 0028; page 15, para. 0037 to page 16, para. 0039. The initial frequency-passband models are combined to form an initial complete three-dimensional geologic model of said subsurface earth volume. *See id.* at Figs. 3 and 5A; page 12, para. 0029 to page 13, para. 0031; page 16, para. 0040 to page 18, para. 0041. Training criteria is specified for the initial complete geologic model and statistics are calculated that describe the characteristics of the assigned rock-property values in the complete geologic model. *See id.* at Figs. 5A; page 16, para. 0041 to page 20, para. 0046. Then, the initial objective function is calculated, rock-property values in the complete geologic model are perturbed so that the rock-property values more closely correspond to the training criteria; the objective function for the new tentative model is calculated; and the perturbed rock-property values and the new tentative objective function are retained if the objective function is reduced. *See id.* at Figs. 5B; page 20, para. 0047 to page 25, para. 0055. These steps are repeated until the objective function is reduced to a specified limit; and then, the final complete geologic model is outputted to file. *See id.*

Beneficially, in constructing the geologic model using the approach of the present techniques, several different rock properties may be modeled independently or simultaneously. These properties include, but are not limited to, porosity, shale volume, net sand percentage, net pore volume, hydrocarbon saturation, hydrocarbon pore volume, and impedance. *See id.* at page 9, para. 0022 to page 10, para 024.

6. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Ground of Rejection No. 1:

Whether claims 1-12 are unpatentable under 35 U.S.C. § 103(a) as being rendered obvious over U.S. Patent No. 6,049,759 to Etgen ("the Etgen reference") in view of U.S. Patent No. 4,679,174 to Gelfand ("the Gelfand reference").

Ground of Rejection No. 2:

Whether claims 13-25 and 27-29 are unpatentable under 35 U.S.C. § 103(a) as being rendered obvious by Etgen and Gelfand in view of U.S. Patent No. 5,838,634 to Jones et al. ("the Jones reference").

Ground of Rejection No. 3:

Whether claim 26 is unpatentable under 35 U.S.C. § 103(a) as being rendered obvious by Etgen, Gelfand, Jones and Applicant's own admission.

7. ARGUMENT

Ground of Rejection No. 1:

The Examiner rejected claims 1-12 under 35 U.S.C. § 103 (a) as being unpatentable over Etgen and Gelfand. Appellants respectfully traverse the rejection for the reasons provided below.

Legal Precedent

The burden of establishing a prima facie case of obviousness falls on the Examiner. *Ex parte Wolters and Kuypers*, 214 U.S.P.Q. 735 (B.P.A.I. 1979). Obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention absent some teaching or suggestion supporting the combination. *ACS Hospital Systems, Inc. v. Montefiore Hospital*, 732 F.2d 1572, 1577, 221 U.S.P.Q. 929, 933 (Fed. Cir. 1984). Accordingly, to establish a prima facie case, the Examiner must not only show that the combination includes all of the claimed elements, but also a convincing line of reason as to why one of ordinary skill in the art would have found the claimed invention to have been

obvious in light of the teachings of the references. *Ex parte Clapp*, 227 U.S.P.Q. 972 (B.P.A.I. 1985). When prior art references require a selected combination to render obvious a subsequent invention, there must be some reason for the combination other than the hindsight gained from the invention itself, i.e., something in the prior art as a whole must suggest the desirability, and thus the obviousness, of making the combination. *Uniroyal Inc. v. Rudkin-Wiley Corp.*, 837 F.2d 1044, 5 U.S.P.Q.2d 1434 (Fed. Cir. 1988).

Further, it should be noted that a *prima facie* case of obviousness may also be rebutted by showing that the art, in any material respect, teaches away from the claimed invention. *In re Geisler*, 116 F.3d 1465, 1471, 43 U.S.P.Q.2d 1362, 1366 (Fed. Cir. 1997). In fact, teaching away from the art is a *per se* demonstration of lack of *prima facie* obviousness. *In re Dow Chemical Co.*, 837 F.2d 469, 5 U.S.P.Q.2d 1529 (Fed. Cir. 1988). In particular, if the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 U.S.P.Q. 349 (C.C.P.A. 1959); see M.P.E.P. § 2143.01.

Claims 1-12

Independent claim 1 recites:

> A method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria, comprising the steps of:
>
> (a) generating an initial frequency-passband model of the subsurface earth volume for at least one frequency passband;
>
> (b) assigning values for at least one rock property in each initial frequency-passband model;
>
> (c) combining the initial frequency-passband models to form an initial complete three-dimensional geologic model of the subsurface earth volume; and
>
> (d) optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria.

In the rejection of independent claim 1, the Examiner asserted that Etgen teaches all of the recited features except "optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to

specified geological criteria." *See* Office Action mailed June 2, 2005, page 5. In an attempt to cure this deficiency, the Examiner asserted that this feature is shown by the Gelfand reference. *See id.* Further, in the Final Office Action mailed November 28, 2006, the Examiner admitted that a velocity model is not a frequency passband model. *See* Final Office Action, page 4. However, the Examiner asserted that the velocity model and a frequency passband model are equivalent under M.P.E.P. § 2183. *See id.* at pages 4-6. Indeed, the Examiner specifically stated that "velocity and frequency are mathematically related and proportional quantities over a given distance" and that "the distinction among model formed by velocity or frequency is not patentably different." *See id.* These assertions and the Examiner's reliance on M.P.E.P. § 2183 appear to be the Examiner's basis for the rejections of claims 1-12.

Despite the Examiner's assertions, Appellants submit that the cited references, alone or in combination, fail to render the claimed subject matter obvious. First, Appellants submit that a velocity model is not equivalent to a frequency passband model and that the Examiner has not established a prima facie case of equivalence. Second, the references fail to disclose or suggest "assigning values for at least one rock property in each initial frequency-passband model" or "optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria," as recited in claim 1. Third, the Examiner's construction appears to change the principle of operation of Etgen and renders it unsatisfactory for its intended purpose. Fourth, the Examiner appears to have relied upon hindsight reconstruction to reject the claimed subject matter. Hence, the cited references do not render the claimed subject matter obvious.

With regard to the first point, Appellants respectfully submit that a velocity model is not equivalent to a frequency passband model and that the Examiner has not established a prima facie case of equivalence. M.P.E.P. § 2183 states that the following rational may be relied upon to establish equivalence:

> (A) performs the function specified in the claim,
>
> (B) is not excluded by any explicit definition provided in the specification for an equivalent, and
>
> (C) is an equivalent of the means- (or step-) plus-function limitation.

These factors must be presented by the Examiner to establish a prima facie case of equivalence. However, Appellants respectfully assert that the Examiner has failed to provide each of these factors.

Regarding step (A) of M.P.E.P. § 2183, a velocity model does not perform the same function as the claimed frequency passband model. First, it should be noted that a frequency passband model is not a model of frequency; rather, it is a model of some property of the subsurface that is limited in frequency bandwidth. In contrast, a velocity model is a model of velocity. As such, one cannot create a frequency passband model of a property, such as porosity, by multiplying a velocity volume by cycles/meter. Also, the process of assigning properties to each frequency passband model is not the same process as filtering a property (velocity) model into single-frequency slices. In support, Appellants submitted a § 1.132 affidavit of a person skilled in the reservoir modeling art (co-inventor Craig S. Calvert) to contradict the Examiner's unsupported assertion that a velocity model is equivalent to a frequency passband model. As such, Appellants submit that a velocity model is not equivalent to a frequency passband model and does not perform the same function as a frequency passband model.

In Etgen, a 3-D velocity model is described as a specification of the subsurface velocity structure as a function of depth for subsurface points located in the vicinity of the survey, which is written as a convolution of a migration operator with the seismic data. *See id.* at col. 3, lines 56-61; col. 5, lines 41-50. The velocity model is then seismically migrated, which is a computationally intensive process. *See id.* at col. 4, lines 47-62. Accordingly, various steps are performed in Etgen to convert a velocity model into various frequency slices that are summed into a single composite volume. *See* col. 5, line 40 to col. 7, line 48. As a result, the single composite volume includes the individual frequencies slices of the volume. Clearly, the Etgen reference differentiates between a velocity model and frequency model, as the entire patent discusses the transformation of the velocity model into individual frequency slices that are summed together to form the composite volume. Further, it should also be noted that the composite volume is not a frequency passband model. The composite volume represents processed seismic data, not a three dimensional geologic model. As such, a velocity model fails to perform the same function as the claimed "frequency-passband model."

In addition, regarding step (C) of M.P.E.P. § 2183, the present claims do not include means- (or step-) plus-function limitations. Under M.P.E.P. § 2181, claim limitations fall under 35 U.S.C. 112, sixth paragraph, when the means for or step for language is specifically stated in the claim. The present independent claims do not include "means for" or "step for" limitations. As such, the Examiner's basis for equivalence also appears to be deficient because the present claims do not include claim limitations under 35 U.S.C. 112, sixth paragraph, which appears to be required by step (C) of M.P.E.P. § 2183. As a result, the Examiner's basis for equivalency under M.P.E.P. § 2183 does not appear to be proper.

With regard to the second point, Etgen and Gelfand do not disclose the claimed subject matter. In particular, the references fail to disclose "assigning values for at least one rock property in each initial frequency-passband model," as recited in claim 1. In the rejection, the Examiner relied on specific passages related to a velocity model and separate single frequency migrated volumes in the Etgen reference to disclose this claimed subject matter. In the Final Office Action, the Examiner further clarified his position by stating "Etgen reference assigns rock properties to the velocity model before forming various frequency passband slices and the applicant assigns rock properties after frequency passband model is formed, both leading to the functionally same results of detailed accurate "rock parameter" assignments." *See* Final Office Action, pages 4-5. Further, the Examiner agreed with the Appellants that Gelfand does not explicitly teach the claimed subject matter. However, Appellants contend that the cited passages and the Examiner's assertions fail disclose or suggest the claimed subject matter, for at least the reasons provided below.

To begin, the Examiner's assertions that a velocity model is equivalent to a frequency passband model is believed to be improper and unsupported, as discussed above. Further, the Examiner appears to admit that Etgen fails to disclose the sequence of claimed steps. Accordingly, the Examiner relies on assertions that the modification of the steps leads to the same functional result. However, as noted above, the process of assigning properties to each frequency passband model is not the same process as filtering a property (velocity) model into frequency slices, which is performed in Etgen. In contrast, the present recitations describe a method for using frequency-limited volumes, not filtering a velocity model. As such, the Examiner's assertions fail to disclose "assigning values for at least one rock property in each initial frequency-passband model," as recited in claim 1.

In addition, the cited passages of Etgen fail to disclose the claimed subject matter. In the cited passages, a 3-D velocity model, which is described as a specification of the subsurface velocity structure as a function of depth for subsurface points located in the vicinity of the survey, is described as a convolution of a migration operator with the seismic data. *See id.* at col. 3, lines 56-61; col. 5, lines 41-50. As an initial step to this process, the velocity model must be specified with each layer characterized. *See id.* at col. 5, lines 58-67. That is, assignments are made as part of the velocity model. Further, Etgen describes that an interpreter specifies rock properties for computations associated with the amplitude and travel time. *See* col. 17, lines 27-62. Clearly, because this velocity model is not a frequency-passband model, assigning rock properties to the velocity model does not disclose "assigning values for at least one rock property in each initial frequency-passband model," as recited in claim 1. As such, the cited passages associated with assigning rock properties in the velocity model do not disclosed the claimed subject matter.

Further, the passages of Etgen associated with the single frequency migrated volumes do not disclose the claimed subject matter. In the cited passages, 3-D Fourier transform coefficients, which represent the seismic data, are derived from a discrete 3-D Fourier transform of the common offset data volume. *See id.* at col. 6, line 62 to col. 7, line 4. With the 3-D Fourier transform coefficients, separate single frequency migrated volumes are computed. *See id.* at col. 7, lines 5-32. However, it does not appear from these passages that rock property values are assigned as part of the operations that create the single frequency migrated volumes. Indeed, as these single frequency migrated volumes are created from the velocity model, Etgen is not believed to suggest assigning rock properties once the separate single frequency migrated volumes are created. As such, Etgen does not disclose "assigning values for at least one rock property in each initial frequency-passband model," as recited in claim 1.

While the Examiner does not rely on Gelfand for these features and even admitted that Gelfand does not disclose the claimed subject matter, the Gelfand reference does not cure the deficiencies of Etgen or the Examiner's assertions. Gelfand describes a method of creating a two dimensional lithologic model within subsurface earth layers over an extended region. *See* Gelfand, col. 2, lines 46-49. In Gelfand, the model is constructed by converting a set of successive processed seismic reflection time-scale traces to a plurality of depth scale models in terms of the layer parameters. *See id.* at col. 2, lines 50-56. Then, a set of synthetic time-scale traces are computed and compared with the original traces. *See id.* at

col. 2, lines 56-58. The parameters are then varied to match the synthetic time-scale traces with the original traces. *See id.* at col. 2, lines 58-67. Clearly, the method of Gelfand does not disclose or suggest generating a frequency-passband model, much less assigning values for rock property in frequency-passband models.

In addition, the references, alone or in combination, do not disclose or suggest "optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria," as recited in claim 1. As noted above, the Examiner acknowledges that Etgen does not disclose or teach this claimed subject matter. Appellants agree with the Examiner that Etgen does not disclose the claimed subject matter.

However, despite the Examiner's assertions, the Gelfand reference does not cure the deficiencies of Etgen. In relying on Gelfand, the Examiner cited to the abstract of Gelfand to disclose this recited feature. *See* Office Action, page 5. However, as noted by the Examiner, Gelfand simply teaches perturbing model-parameters in a two-dimension lithologic model. *See* Gelfand, Abstract. This passage does not disclose or teach a frequency-passband model, much less optimizing the three-dimensional geologic model by perturbing rock property values in at least one frequency-passband model. As such, Gelfand does not disclose "optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria," as recited in claim 1.

With regard to the third point, the Examiner's construction appears to change the principle of operation of Etgen and renders it unsatisfactory for its intended purpose. As noted above, the velocity model in Etgen undergoes various computationally intensive processes to form the single composite volume. *See id.* at col. 4, lines 47-62; col. 5, line 40 to col. 7, line 48. As a result, the Examiners proposed modification changes the principle of operation of Etgen by attempting to replace a velocity model utilized as the starting point of the Etgen process with a single composite volume in frequency, which is the end result of the Etgen process. In fact, the velocity model undergoes computationally intensive operations to form the single composite volume in frequency. By attempting to interchange the velocity model with the single composite volume in frequency, the Examiner renders the prior art unsatisfactory for its intended purpose. Accordingly, the Examiner's proposed modification is not suggested or supported by Etgen.

With regard to the fourth point, the Examiner appears to have relied upon hindsight reconstruction to reject the claimed subject matter. As noted above, the Examiner relied upon various assertions because the references are devoid of the certain claimed subject matter. In particular, the Examiner asserted that a velocity model is equivalent to a frequency passband model. Yet, nothing in the cited references describes using a frequency-passband model in the claimed manner. Further, while admitting the sequence of steps in the present claims is not shown by Etgen, the Examiner provides assertions that the claimed subject matter and the disclosure in Etgen are equivalent in an attempt to teach the claimed subject matter. As such, it is submitted that the Examiner is relying on the present application as the basis for combining these references along with the Examiner's assertions of equivalence to reject the claimed subject matter. As such, Appellants contend that the Examiner is impermissibly relying on knowledge learned from the present application to combine the references for the rejection.

Accordingly, because the references fail to disclose *all* of the claimed elements, the references fail to provide support for a *prima facie* case of obviousness. Further, the Examiner appears to have impermissibly modified the Etgen reference and uses hindsight in an attempt to reject the claims, as set forth above. Therefore, independent claim 1 and respective dependent claims are believed to be patentable over Etgen and Gelfand, alone or in combination.

<u>Ground of Rejection No. 2</u>:

The Examiner rejected claims 13-25 and 27-29 under 35 U.S.C. § 103 (a) as being unpatentable over Etgen, Gelfand and Jones. Appellants respectfully traverse the rejection.

Claims 18-25 and 27-29

Independent claim 18 recites:

> A method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria, comprising the steps of:
>
> (a) specifying an initial geologic architecture to define the limits of the model, the regions within the model, and stratigraphic correlations within the model;

(b) creating a three-dimensional array of contiguous model blocks to represent all portions of the subsurface earth volume to be included within the model;

(c) assigning initial rock-property values to all model blocks in at least one initial frequency-passband model;

(d) combining the initial frequency-passband models to form an initial complete three-dimensional geologic model of said subsurface earth volume;

(e) specifying training criteria for the initial complete geologic model;

(f) calculating statistics that describe the characteristics of the assigned rock-property values in the complete geologic model;

(g) calculating the initial objective function;

(h) perturbing the rock-property values in the complete geologic model so that the rock-property values more closely correspond to the training criteria;

(i) calculating the objective function for the new tentative model;

(j) retaining the perturbed rock-property values and the new tentative objective function if the objective function is reduced;

(k) repeating steps (h) through (j) until the objective function is reduced to a specified limit; and

(l) outputting the final complete geologic model to file.

In the rejection of independent claim 18, which is the similar to the rejection of independent claim 1, the Examiner asserted that Etgen and Gelfand teach all of the recited features except "specifying training criteria for the initial complete geologic model," "calculating statistics that describe the characteristics of the assigned rock-property values in the complete geologic model," "calculating the initial objective function," "perturbing the rock-property values in the complete geologic model so that the rock-property values more closely correspond to the training criteria," "calculating the objective function for the new tentative model," "retaining the perturbed rock-property values and the new tentative objective function if the objective function is reduced," "repeating steps (h) through (j) until the objective function is reduced to a specified limit" and "outputting the final complete geologic model to file." *See* Final Office Action, pages 11-12. In an attempt to cure these deficiencies, the Examiner asserted that these features are provided by the Jones reference.

However, despite the Examiner's assertions, Appellants submit that the cited references, alone or in combination, fail to render the claimed subject matter obvious. First, Appellants submit that a velocity model is not equivalent to a frequency passband model and that the Examiner has not established a prima facie case of equivalence. Second, the references fail to disclose or suggest "assigning initial rock-property values to all model blocks in at least one initial frequency-passband model," as recited in claim 18. Third, the Examiner's construction appears to change the principle of operation of Etgen and renders it unsatisfactory for its intended purpose. Fourth, the Examiner appears to have relied upon hindsight reconstruction to reject the claimed subject matter. Hence, the cited references do not render the claimed subject matter obvious.

With regard to the first point, Appellants respectfully submit that a velocity model is not equivalent to a frequency passband model and that the Examiner has not established a prima facie case of equivalence. Again, as noted above, a velocity model does not perform the same function as the claimed frequency passband model. Further, the Etgen reference even provides a clear distinction between a frequency model and a velocity model. Finally, the present claims do not include means- (or step-) plus-function limitations, as required by the Examiner's construction under M.P.E.P. § 2183. As a result, the Examiner's basis for equivalency under M.P.E.P. § 2183 does not appear to be proper.

With regard to the second point, the references do not disclose "assigning initial rock-property values to all model blocks in at least one initial frequency-passband model," as recited in claim 18. As noted above in the discussion of claim 1, Etgen describes a method for processing seismic data, while Gelfand describes a method of creating a two dimensional lithologic model. As the Examiner has again relied upon similar passages to those discussed above with regard to claim 1, Appellants reiterate that this claimed subject matter is not disclosed or taught for at least the reasons discussed above. Accordingly, the Etgen and Gelfand references do not disclose or teach "assigning initial rock-property values to all model blocks in at least one initial frequency-passband model," as recited in claim 18.

Further, the Jones reference does not cure the deficiencies of Etgen and Gelfand. Jones describes a method of creating a three dimensional geologic model of the earth's subsurface. *See* Jones, col. 6, lines 47-52. In Jones, the process merges 3-D geologic modeling with forward seismic modeling to produce a model that consistent with geologic and geophysical principles. *See id.* at col. 6, lines 52-62. Then, the model perturbs the rock

properties in the geologic model until the model is consistent with geologic and geophysical data and interpretations. *See id.* at col. 6, lines 62-67. Clearly, the method of Jones does not disclose or suggest a frequency-passband model, much less, assigning rock-property values to blocks in the frequency-passband model. As such, Jones does not disclose "assigning initial rock-property values to all model blocks in at least one initial frequency-passband model," as recited in claim 18.

With regard to the third point, the Examiner's construction appears to change the principle of operation of Etgen and renders it unsatisfactory for its intended purpose. As noted above in the discussion of claim 1, the Examiners proposed modification changes the principle of operation of Etgen by attempting to replace a velocity model utilized as the starting point of the Etgen process with a single composite volume in frequency. Accordingly, the Examiner's proposed modification renders it unsatisfactory for its intended purpose. As such, the Examiner's proposed modification is not suggested or supported by Etgen.

With regard to the fourth point, the Examiner appears to have relied upon hindsight reconstruction to reject the claimed subject matter. As noted above, the Examiner relied upon various assertions because the Etgen, Gelfand and Jones references are devoid of the claimed subject matter. Indeed, the Examiner asserted that a velocity model is equivalent to a frequency passband model. Again, nothing in the cited references describes the claimed use of frequency passband models in creating a three-dimensional geologic model. As such, it is submitted that the Examiner is relying on the present application as the basis for combining these references to reject the claimed subject matter. As such, Appellants contend that the Examiner is impermissibly relying on knowledge learned from the present application to combine the references for the rejection.

Accordingly, because the references fail to disclose *all* of the claimed elements, the references fail to provide support for a *prima facie* case of obviousness. Further, the Examiner appears to have impermissibly modified the Etgen reference and uses hindsight in an attempt to reject the claims, as set forth above. Therefore, because independent claim 18 and respective dependent claims are believed to be patentable over Etgen, Gelfand and Jones, alone or in combination, Appellants respectfully request that the board overturn the rejection of claims 18 and the respective dependent claims.

Claims 13-17

Furthermore, claims 13-17 depend from independent claim 1, and are believed to be patentable based on this dependence. In the rejection, the Examiner admitted that the Etgen and Gelfand references do not disclose or teach the subject matter of claims 13-17. In an attempt to cure the deficiencies, the Examiner relied on the Jones reference to cure deficiencies of Etgen and Gelfand. However, as discussed above with regard to claim 18, Jones does not cure the deficiencies of Etgen and Gelfand. Specifically, Jones does not disclose or suggest "assigning values for at least one rock property in each initial frequency-passband model" or "optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria," as recited in claim 1, as recited in claim 1. As such, because Jones does not disclose the recited features of independent claim 1, the Jones reference fails to cure the deficiencies of Etgen and Gelfand for at least the reasons cited above.

Accordingly, in view of the remarks set forth above, Appellants respectfully submit that the Etgen, Gelfand and Jones references cannot support a *prima facie* case of obviousness. Therefore, Appellants respectfully request the Board overturn the Examiner's rejection of claims 13-17.

Ground of Rejection No. 3:

The Examiner rejected claim 26 under 35 U.S.C. § 103(a) as being unpatentable over Etgen, Gelfand, Jones and Applicant's own admission. Appellants respectfully traverse the rejection.

Claim 26 depends from independent claim 18, and is believed to be patentable based on this dependence. In the rejection, the Examiner relied upon a passage in the present application in an attempt to disclose certain subject matter, as obvious to one of ordinary skill in the art. However, the passage relied upon by the Examiner fails to cure the deficiencies of Etgen, Gelfand and Jones. In this passage, Applicants state that the rank-transform "method, known to persons skilled in the art of geologic modeling, resets the tentative cumulative frequency distribution of porosity calculated from the tentative geologic model to the desired cumulative frequency distribution of porosity." *See* Application, page 22, section (b). This passage, which simply describes a know rank-transform method, fails to suggest or teach

"assigning initial rock-property values to all model blocks in at least one initial frequency-passband model," as recited in claim 18. As such, the passage fails to cure the deficiencies of Etgen, Gelfand and Jones.

Accordingly, because the references and the alleged admission fail to disclose *all* of the claimed elements, the references and the alleged admission fail to provide support for a *prima facie* case of obviousness. Therefore, claim 26 is believed to be patentable over the cited references, alone or in combination.

CONCLUSION

In view of the above remarks, Appellants respectfully submit that the Examiner has provided no supportable position or evidence that claims 1-29 are rendered obvious in view of the prior art references. Accordingly, Appellants respectfully request that the Board find claims 1-29 patentable over the prior art of record and reverse all outstanding rejections.

Appeal Brief Fee and General Authorization for Extensions of Time

The Commissioner is authorized to charge the requisite fee of $500.00, and any additional fees which may be required, to Deposit Account No. 05-1328. Further, in accordance with 37 C.F.R. § 1.136, Appellants hereby provide a general authorization to treat this and any future reply requiring an extension of time as incorporating a request therefor.

Respectfully submitted,

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APPENDIX OF CLAIMS ON APPEAL

(Attached - 5 pages)

APPENDIX OF CLAIMS ON APPEAL

[c1] A method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria, comprising the steps of:

(a) generating an initial frequency-passband model of the subsurface earth volume for at least one frequency passband;

(b) assigning values for at least one rock property in each initial frequency-passband model;

(c) combining the initial frequency-passband models to form an initial complete three-dimensional geologic model of the subsurface earth volume; and

(d) optimizing the initial complete three-dimensional geologic model by perturbing the rock property values in at least one of the models according to specified geological criteria.

[c2] The method of claim 1, wherein a tentative frequency-passband model is generated for at least one of a low-frequency passband, a mid-frequency passband, a high-frequency passband, and a full-frequency passband;

[c3] The method of claim 2, wherein a seismic-frequency passband represents the mid-frequency passband.

[c4] The method of claim 2, wherein an existing geologic model represents the full-frequency passband.

[c5] The method of claim 1, wherein the step of generating an initial model for a frequency passband comprises the steps of

(a) specifying an initial geologic architecture to define the limits of the model, the regions within the model, and stratigraphic correlations within the model; and

(b) creating a three-dimensional array of contiguous model blocks to represent all portions of the subsurface earth volume to be included within the model.

[c6] The method of claim 1, wherein the step of generating a initial model for a frequency passband comprises the steps of

(a) specifying an initial geologic architecture to define the limits of the model, the regions within the model, and stratigraphic correlations within the model; and

(b) creating a three-dimensional array of discrete model points to represent all portions of the subsurface earth volume to be included within the model.

[c7] The method of claim 1 wherein each rock property value is a measurable property of the subsurface volume selected from a group consisting of porosity, shale volume, net sand percent, net pore volume, hydrocarbon saturation, hydrocarbon pore volume, impedance, and permeability.

[c8] The method of claim 1, wherein a plurality of rock properties are assigned to each initial frequency-passband model.

[c9] The method of claim 1, wherein each assigned rock-property value is consistent with the frequency content of the corresponding initial frequency-passband model.

[c10] The method of claim 1, wherein the initial complete geologic model is formed from a single initial frequency-passband model.

[c11] The method of claim 1, wherein the initial complete geologic model is formed by summation of all initial frequency-passband models.

[c12] The method of claim 1, wherein the initial complete geologic model is formed by weighted summation of the initial frequency-passband models in the frequency domain.

[c13] The method of claim 1, wherein the step of optimizing the initial complete three-dimensional geologic model by perturbing the rock-property values comprises the steps of:

(a) specifying training criteria for at least one initial model, said training criteria being consistent with the frequency content of the corresponding model;

(b) calculating statistics that describe the characteristics of the assigned rock-property values in the at least one model;

(c) calculating the initial objective function;

(d) perturbing the rock-property values in the at least one initial model so that the rock-property values more closely correspond to the training criteria;

(e) calculating the objective function for the new tentative model;

(f) retaining the perturbed rock-property values and the new tentative objective function if the objective function is reduced;

(g) repeating steps (d) through (f) until the objective function is reduced to a specified limit; and

(h) outputting the final complete geologic model to file.

[c14] The method of claim 13, comprising the further step of:

(a) outputting each final frequency passband model to file.

[c15] The method of claim 13, wherein the subsurface earth volume includes more than one region and specified training criteria are unique for each region.

[c16] The method of claim 13, wherein the rock-property values in the initial complete geologic model are perturbed by simultaneously optimizing more than one initial model.

[c17] The method of claim 13, wherein the frequency content of each tentative model is maintained during perturbation of the rock-property values.

[c18] A method for constructing a three-dimensional geologic model of a subsurface earth volume according to specific geological criteria, comprising the steps of:

(a) specifying an initial geologic architecture to define the limits of the model, the regions within the model, and stratigraphic correlations within the model;

(b) creating a three-dimensional array of contiguous model blocks to represent all portions of the subsurface earth volume to be included within the model;

(c) assigning initial rock-property values to all model blocks in at least one initial frequency-passband model;

(d) combining the initial frequency-passband models to form an initial complete three-dimensional geologic model of said subsurface earth volume;

(e) specifying training criteria for the initial complete geologic model;

(f) calculating statistics that describe the characteristics of the assigned rock-property values in the complete geologic model;

(g) calculating the initial objective function;

(h) perturbing the rock-property values in the complete geologic model so that the rock-property values more closely correspond to the training criteria;

(i) calculating the objective function for the new tentative model;

(j) retaining the perturbed rock-property values and the new tentative objective function if the objective function is reduced;

(k) repeating steps (h) through (j) until the objective function is reduced to a specified limit; and

(l) outputting the final complete geologic model to file.

[c19] The method of claim 18; wherein each rock property value is a measurable property of the subsurface volume selected from a group consisting of porosity, shale volume, net sand percent, net pore volume, hydrocarbon saturation, hydrocarbon pore volume, impedance, and permeability.

[c20] The method of claim 18, wherein an assigned rock-property value is consistent with the frequency content of the corresponding initial frequency-passband model.

[c21] The method of claim 18, wherein the initial complete geologic model is formed from a single initial frequency-passband model.

[c22] The method of claim 18, wherein the initial complete geologic model is formed by summation of all initial frequency-passband models.

[c23] The method of claim 18, wherein the initial complete geologic model is formed by weighted summation of the initial frequency-passband models in the frequency domain.

[c24] The method of claim 18, wherein the step of perturbing the rock-property values comprises a series of sequential steps, wherein each step attempts to force a nearly perfect fit of the model statistics to one of the training criteria.

[c25] The method of claim 24, wherein one of the steps includes replacing tentative rock-property values, in blocks intersected by the boreholes of wells, by corresponding values observed at each intersecting borehole segment.

[c26] The method of claim 24, wherein one of the steps includes replacing tentative rock-property values in all model blocks by resetting the tentative cumulative frequency

distribution of a rock property to the desired cumulative frequency distribution of the property using a rank-transform method.

[c27] The method of claim 24, wherein one of the steps includes simultaneously perturbing rock property values in all blocks of the complete geologic model by replacing its tentative 3-D amplitude spectrum with a desired amplitude spectrum.

[c28] The method of claim 18, wherein at least one region is defined within the subsurface earth volume to be modeled and desired values for training criteria are unique for each region.

[c29] The method of claim 18, further comprising the step of providing a suitably programmed digital computer to perform one or more of steps (a) through (l).

EVIDENCE APPENDIX

Calvert Affidavit

(Attached - 2 pages)

RELATED PROCEEDINGS APPENDIX

None.